Romanticism and Science Education
Nature as a Poem

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Abstract

This philosophical poetic inquiry argues for relational approaches and creative expression in university science education. Poetic inquiry as a methodology can cultivate connection to the other-than-human world that promotes contemplative practice and a reciprocal relationship with life phenomena under study. Throughout this philosophical inquiry I incorporate my own poems and photography, both as a Romanticism-inspired praxis, and to elucidate the vital importance of an ethical-holistic pedagogy in the current era of human-powered climate change, dramatic species extinction, and habitat destruction. Goethean science, where students understand nature inwardly, offers an alternative to Newtonian science by incorporating the intentionality of phenomenological learning and the development of ecological literacy. If we approach the scientific method with wonder and ethical-ecological holism, we might fully acknowledge our moral responsibility toward the biosphere and all earthly beings.

Keywords: Romanticism; poetic inquiry; science education; arts-based learning; philosophy of education
Romanticism and Science Education

Nature as a Poem

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Introduction from the Amazon

The rain forest is alive with sound. Vines hang like snakes on every branch of every tree. The air is heavy with rain yet to fall. My thirteen students are trekking through primary tropical rainforest, the greatest terrestrial biodiversity on our planet. This setting is their teacher.

I have travelled with Kwantlen Polytechnic University’s (KPU) Interdisciplinary Amazon Field School three separate years. Students with diverse backgrounds share an experience of cultural, geographical and ecological immersion. This is a collaboration between KPU and the Calanoa Project, founded by Marlene and Diego Samper. Calanoa is a private natural reserve located at the very heart of the Amazon rainforest and offers students the opportunity to engage in an intensive cross-disciplinary field study focused on integrating personal growth, nature experience, and reflective scholarship.

As a poet-scientist-philosopher my intention, both on this field school and in this paper, is to promote reflective and relational learning with university students

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through poetry, arts-based teaching, and direct nature experience. I will argue that if we approach the scientific method with wonder and reciprocity, we might fully acknowledge our moral responsibility toward the biosphere and all earthly beings. I incorporate my own poems and photography throughout, both as a Romanticism-inspired praxis and to elucidate the vital importance of an ethical-holistic pedagogy in the current era of human-powered climate change, dramatic species extinction, and habitat destruction.

But first, let us return to the Amazon. As my students breathe in the rainforest, serenaded by choruses of insects, amphibians, and the occasional primate, everything begins to feel more permeable, more interconnected. At one point our intrepid guide, named Elvis, gets stung by an aggressive wasp. He retreats from the nest and trail blazes us a new path to circumvent the danger. Here in the Amazon nature commands respect and a reciprocity with the wild. Humans are but a single species in a vast cauldron of biodiversity, no place more evident than here. As David Abram (1996) says, “We are human only in contact, and conviviality, with what is not human” (22). The other-than-human voices of the Amazon are many. Should we learn to listen, each species becomes a unique teacher.

Amazonia
every leafblade watches you
a study for each pupil
unfurls vision that never blinks
mentors through mystery and survival
a million lessons for those who listen

Ants
carve roads with six-legged fortitude
the way Maxine Greene speaks of the quest
a tornado of pheromone forges the path
one antennae twitch perceived by all
a tsunami that ripples through the colony

Dolphin
he glides through water’s pedagogy
locating echoes of our evolution
fabled fins that once walked on land
this shape-shifting intelligence
narrates my ocean ancestry

Mosquito
buzz I want to slap
before that bloodsucker slips past my skin
this pest food for bat and bird
shows me a knot in the food web
and the human-made holes we cannot stitch

Strangler Fig
parasitic teacher that means well
star-stretcher first, then root digger
coddles with an overkill of material
the student becomes but a shadow
inner cavity hallowed of creativity

Tarantula
I fear those eight anxious appendages
an undulant of waves along the cabin wall
why does my stomach lurch before this beauty?
such delicacy in her gesture and touch
slows my heart in trepidation
Anaconda
limbless queen of the jungle river
with skin that weds sinuous to simple
no fingers to point or vertebrae to raise
to swim climb slither prey
this boa swallows caiman whole

Sloth
a still and single-minded reminder
patient guru of three-toed precision
slow life in a singular ceiba tree
every blink and breath a precious play
reflected in the year’s long second

Amazonia
vast cauldron of leaf and fang
simmers with life’s cardinal seed
a place terror and wonder collide
caught in the jaguar’s perfect gaze
do you look or
do you look away?

When a student is tasted by a mosquito, gasps at the sight of a dolphin fin breaking
the Amazon River surface, or shudders as eight hairy tarantula legs rambles across
their cabin wall, such encounters jog our senses and attune our awareness. They re-
mind us of our bodies’ amazing vulnerability. Such visceral and pre-rational re-
sponses, in this “place where terror and wonder collide,” cue us toward the ecological
concept that we are but a small part of nature, interwoven into a larger tapestry.

Approaching the end of our trek, I look up to see the rain, tiny flecks caught in
equator sunlight. Except behind every leaf the sky is blue. It takes a moment to re-
gister: this isn’t rain, it’s insects. Thousands upon thousands in descent, flitting to
and fro, ubiquitous enough to be mistaken for precipitation. The awe of this moment snaps me to attention. Is this the kind of wonder experienced by Humboldt and Darwin in the Americas when they first ventured, respectively, to the Andes and Galápagos Islands?

Our final yet most profound engagement with the forest happens off the well-trodden path. Elvis machetes his way down to a huge ceiba tree, its buttressed trunk grasping the surrounding earth like the talons of a giant harpy eagle. For the Mayans, the ceiba tree served as bridge between the Earth and the spirit-world. “Place your hands on this ancient mother tree,” Elvis explains. “Close your eyes for two minutes. Then let out a primal scream into the jungle. This scream is a release of some weight, hurt, or anxiety that we (or someone close to us) carries.” The students all take part, and we immerse in an all-too-rare moment of silent reverie. The resultant screams come from a place somewhere deep, a place usually kept behind the walls of reason and etiquette. The macaws perched above tilt their heads in curiosity at the shrill cries of these two-leggeds.

We load back into our small boats, heading out onto Matamata Creek and the twilit tunnels of forest flooded by the wet season. As I paddle the dark waters, I ponder on the teachings of the forest and the river. What lessons, forgotten by civilization, can this wild place teach us?

Matamata

the pulse of flooded Amazonia
thrums through our canoe
the current
every leaf and vein
sparks light
the paddle in my hands
a Colombian Excalibur
king of the river
her sunken secrets
hidden beneath
the turtle’s earthen shell

I wipe away
the malarial blood
of squashed mosquitos
my nose wrinkles
at deet mixed
with forest sweat
my pores open
to the vascular
wilderness within
my skin tunnels
a memory of
death and breath

Matamata
you meander
wide round
bending light
your cauldron of algae
captures a
chlorophyll feast
you swallow roots
flood the forest
overflow your banks
with dolphins
under blackwater
tannin-leached artery
apalpitates
what lurks?
at the surface mirror
whose nostrils?
    anaconda
light falls
    insects buzz
    black bird cries
a sunset drone
for hunger and sex

remember
your wild blood
    and feral heart
recover the soul
    of the shaman
    his scream silent
    as the water lung
    louder than
the darkness

Something ancient stirs in this river flooded ten meters deeper by rains in distant highlands. The poem, “Matamata,” speaks to the effects of the “sunset drone” and “forest sweat” on our cultured—or even academic—bodies. Beyond the rational, the intellectual, the logically defined is the spirit of our “wild blood” that connects us to this place. This remembrance pokes holes between the civilized and wild, the objective and subjective, the material and spiritual, forming a porous membrane that teaches us to own and embrace, rather than shun, our so-called primitive qualities. Intuition, awakened senses, humid sweat, and even the possibility of lurking dangers are all gifts heightened by immersive nature experience.
Students must prepare for this experience. While the Amazon Field School offers a tremendous opportunity for place-based learning, where the arts (drawing, photography, writing, etc.) can be explored alongside the sciences (chemistry, ecology, fluvial geomorphology, etc.), it also stretches our bodies and challenges our beliefs. Students need to bring a certain level of maturity, an openness to other ways of thinking and being, a willingness to be bitten, sunburnt, sweat-soaked, and an understanding of the power of vulnerability. Brené Brown (2013) has shown vulnerability to be the birthplace of innovation and creativity, a place for transformative opportunity. Throughout the Amazonia experience, students engage in reflective journaling, group discussion, and debrief sessions, in the hopes that any feelings of overwhelm or discomfort become opportunities for growth, or in some cases transformation.

Lessons from the Romantics

In the remainder of this paper, I will outline the ideology of Romanticism and the aesthetic, holistic and moral qualities it can offer science education. I will argue that poetry and poetic inquiry (Sameshima, Fidyk, James, and Leggo 2017) in university can be employed to engage students in a participant mode of consciousness and raise questions about post-secondary science pedagogy that positivism and Cartesian-Newtonian models de-emphasize. Can we engage in holistic-based, wonder-filled science education that happens in local ecosystems, or even within the confines of a conventional classroom? How can we re-integrate science, philosophy and the fine arts? How can we return to a more permeable relationship with nature, one that cultivates an ethical consideration of the more-than-human? Learnings from the Romantic era can help us answer these questions. Writing poetry presents one avenue toward understanding our relationship with the natural world, participating with the other-than-human consciousness, and the interweaving of science and art.
Next, I will examine poetic inquiry as a reflective and inhabiting methodology that can build connective tissue among human, other-than-human, and place, and later outline some science-based poetic teaching practices using ethical-holistic pedagogy. Where ecology attempts to study scientifically everything in relation, holism is its philosophical twin. Reductionism, or the investigation of phenomena in isolation, “can only give us a partial view of anything it dissects” (Miller 2000, 21). As such, we should contemplate the world as an interwoven tapestry lacking loose threads. Métissage (Hasebe-Ludt, Chambers, and Leggo 2009) will help integrate and conceptualize my inquiry in order to bring forth scientific, artistic and philosophical voices. I will braid lenses of inquiry with a variety of my own personal voices: academically inspired, poetic works, photography—and the lived-experiential writing found previous.

Western civilization’s privileging of the mind over the body enables a human-nature dualism and general desensitization from nature that discourages unity between epistemic object and epistemic subject (Abram 2011; Bai 2012; Hadzigeorgiou and Skoumios 2013; Matthews 2008). During the Romantic era (late 1700s to roughly 1900) the natural sciences unified human beings and nature, and Romantic scientists enriched their work with aesthetic and moral qualities such as drawings, creative writings, and a deep relationality that blurred the line between subject and object. As Hadzigeorgiou and Schulz (2014) explain, “The ‘Romantic’ scientists believed in an infinite and mysterious nature, whose study was similar to an aesthetic experience, and which was characterized by the experience of wonder, poetic inspiration and creativity” (1977). Science was not yet siloed from art and philosophy. Goethean science, where students understand nature inwardly, offers an alternative to Newtonian science by incorporating the intentionality of phenomenological learning and the development of ecological literacy (Cohen 2007). Goethe (1790/1988) asks us to engage directly with our subjects and avoid ontological reversal (Harvey 1989) where models take on more importance than the phenomenon under study. This common
practice happens, by example, when a student studies abstract photosynthetic mechanisms without examining an actual leaf, more concerned with chemical formulae and electrons than the wonder and welfare of the photosynthesizing plant.

Darwin was a Romantic scientist, although he would have called himself a natural philosopher (philosophia naturalis), as the word scientist, coined by scientist/philosopher William Whewell, did not enter the popular vernacular until the mid-1800s. The telling difference between natural philosopher and scientist is the removal of philosophy from science. Modern scientific studies seldom engage with ethics or philosophical discourse; this is reserved for other disciplines. Darwin’s theory of natural selection, one of science’s greatest discoveries, unifies all the myriad fields of biology (Darwin 1859/1998). Anatomy, ecology, genetics, cell biology, and developmental biology all dance to the rhythms of evolution the same way planets and moons dance to the laws of gravity. As a Romantic scientist (Richards 1987) Darwin was able to envision natural selection by examining phenomena in a perennial and inclusive manner, through eyes that saw the dynamic creativity of the world. Such a holistic and prescient ideology that unites divergent disciplines is vital in today’s interdisciplinary world where, for example, climate change studies require biologists, geochemists, meteorologists, mathematicians, oceanographers and others to intimately collaborate.

How can holistic education in university, especially one that is experiential, reflective, and reciprocative, cultivate wonder in learners that influences their academic and ethical decisions? If we want to develop a relationally constructed autonomy and responsibility, the often atomistic scientific methodology needs to engage in cross-disciplinary pollination. Miller (2000) warns of strict intellectual training that leads to colonial thinking such as “how to gain knowledge over the world” (68); Hadzi-georgiou and Schulz (2014) suggest that we reclaim the Romantic conception of science where aesthetic, contemplative and moral deliberation (Richards 2002) fosters
an ethical-holistic purpose (Kearns 2015). Holism is an anti-reductionist view that recognises the wholeness of our beings. Hadzigeorgiou and Schulz (2014) expand on this,

As a philosophy of education, holistic education is based upon the idea that meaning can be constructed through multiple connections to both the natural world and the community. In this sense, a ‘holistic experience’ is an experience that encourages unity between a subject and his/her environment (including his/her object of study), through physical, emotional cognitive, and even spiritual involvement with it (1987).

Through the lens of Romanticism, and inspired by Goethean science that promotes empathy and prolonged looking towards a non-dualistic unity (Robbins 2005; Wahl 2005), perhaps there is an alternative paradigm of, and methodology for, science that fully acknowledges and requires humans’ moral responsibility toward all earthly beings and our mutual flourishing? I will argue that poetry is one such method that promotes contemplative practice and a reciprocal relationship with the phenomena under study. Poetic inquiry can facilitate reflection and sensorial engagement, build connective tissue, and fine-tune our understanding via concise language and poignant metaphor. Poetry opens new doors of perception.

The Mexican poet-diplomat Octavio Paz contends that poetry is the remedy for “resisting modern man’s accelerating flight from the Garden of Eden into a world made pallid and plastic by technological glut” (Sherman 2009, 89). Sherman expands this further,

The remedy is poetry, of course, poetry as fact and as metaphor to repair the augmenting gulf between man and his surroundings, man and his being. There are two necessary steps: first, a profound contemplation of nature until we are in tune with its rhythms, can hear and articulate them, can overcome our instinctive fear of alien forces; and then, an essential recovery of that nothingness
which precedes being, that state of benign uncertainty which is the original but corrupted source of the bastardized progeny which currently afflict us: futility, anxiety, boredom. (89)

This suggests that poetic inquiry is more than mere words on a page or language poiesis. Poems have the potential to be transformational both for the poet and for her or his readers, and in a larger socio-political context.

**Poetry as Intimate Inquiry**

I think that we’re beginning to remember that the first poets didn’t come out of a classroom, that poetry began when somebody walked off of a savanna or out of a cave and looked up at the sky with wonder and said, “Ahhh.” That was the first poem. (Clifton 2010).

Documented poetry, such as Homer’s *Odyssey* and Valmiki’s *Ramayana*, have existed for thousands of years, while oral poetics in the form of song or hymn date even further back. Poetic inquiry can be seen as a subset of poetry that serves as intentional research. Before I distinguish these further, let us review what several celebrated poets have to say about poetry.

“A poet’s work is to name the unnameable,” says Salman Rushdie, “to point at frauds, to take sides, start arguments, shape the world, and stop it going to sleep” (as cited in Andrews 1993, 699). Rushdie emphasizes the transformative nature of poetry, and its ability to provoke conversations that matter and keep the truth alive. Robert Frost explicates the way poetry unearths the unknown: “I have never started a poem yet whose end I knew. Writing a poem is discovering” (as cited in Wiggerman and Meischen 2015, “Junk Drawers” para 12). Poetry is not a product but a process that comes to light through the act of living poetically, or constructing possibilities in the way Carl Leggo (2015) describes: “language is dynamic and energetic, and opens
up possibilities for understanding our lives and experiences and relations” (178). In summary, then, poetry is an engagement with discovery and wonder that acts as a bridge of understanding across divergent realms, prompting us to excavate and access the inaccessible.

Poetic inquiry uses poetry to study and consider fuller understandings of a research subject (Faulkner 2009; Prendergast 2009a; Wiebe 2008). This type of qualitative research is often contemplative in nature, and can help clarify our place in and feelings toward the more-than-human world. Through poetic inquiry—that is, through the rumination of a subject or experience, thoughtful word choice and use of imagery, and careful construction of a poem that may include “metaphor, lyric, rhythm, imagery, emotion, attention, wide-awakeness, opening to the world, self-revelation” (Prendergast 2009b, xxxvii)—one can deepen understanding of both I and the Other, and the relational space between. The visceral and evocative nature of poetry can bring the subject alive and forge a reciprocal relationship between the observer and the observed, blurring the lines that separate object and subject, human and nonhuman, teacher and student. Ellsworth describes this as “a location that defies the binaries of inside/outside, self/other, subject/object—a space of relation” (McKenzie 2008, 365). Inside this space of relation, and in the expression of affective experiences, we engage with our ecological self and thereby become aware of the larger ecologies that surround us.

Carl Leggo (2004) writes, “the poet is a human scientist” (30) who works with language to construct understanding. Science as a methodology utilizes objective data collection and analysis in order to better understand the outer universe, while poetry is a method that subjectively discerns our internal and external worlds and all of the relationships therein. Paz describes poetic experience as “the act of uncovering [that] involves the creation of that which is to be uncovered: our own being” (as cited in Sherman 2009, 89). Put another way, science examines external material truths while
poetry (or more generally, art) scrutinizes what it means to be the human animal. In some examples, poetry explores the *umwelt* of other-than-human species (Beavington 2017). Poetry acts as a gateway “between inner and outer realities” (Ellsworth 2005). As de Bolla (2001) writes, “poetic, painterly, or musical knowings arise from a place more elemental than intellectualisation” (8). Poetry thus offers us intimate access to a world largely explained by sterile science, at least in the dominant western culture, and both reconnects our senses with this world and ponders the questions that science has difficulty addressing. What is alive? What is human? What is our responsibility to the world? How are my body and being connected to other life phenomena?

Poetic inquiry can be seen as a specific form of poetry employed with intention for research or teaching. Data collected from interviews, journals, assignments, photographs or lived experience can be mined and moulded into a poem in order to express an idea or experience in a precise and provocative manner. Elliott (2012) defines poetic inquiry (through Emerson) as “the work of truth-seeking contemplation and inward observation itself” (17). Ultimately, Emerson envisions poetry and poetic inquiry as inseparable: “The true philosopher [i.e., the scholar] and the true poet are one, and a beauty, which is truth, and a truth, which is beauty, is the aim of both” (as cited in Elliott 2012, 17).

**An Ecopoetic Inquiry**

Prendergast (2009b) explains that poetry of all forms can “be a form of research, a researching of experience and sorting into expression and communication through language” (xxii). I have used poems as assignments, papers, and research, as a way to find “unity in variety” (Bronowski 1956/1972, 20), that is, to tie tightly together the common themes that underlie seemingly divergent realms. As Bronowski further explains, “The discoverer or the artist presents in [science or works of art] two aspects
of nature and fuses them into one” (19) or as Serres (1995) puts it, “A cluster of highly different relations becomes a body” (101). When we recognize our interrelations with other species, and conceive of our human bodies as but a smaller piece of the Earth’s body, we may become aware that we are but one knot in the biosphere’s infinite relationality. This work deepens my understanding of self and my purpose in the world. By synthesizing various modes of perception, poetic inquiry becomes a way of paying attention and clarifying intention. With this in mind, I offer the following poems.

Every inhalation and exhalation inextricably connects us to the animals, plants, and geography of our personal locus. Even the air itself is part and parcel of our bodies. “We mistakenly go out into the world to find life,” writes Jarvis (2009), “a life which, however, there is no need for us to ‘find’, since it is, necessarily, just what we already are” (362). Holding firm to this idea that we are life, and that “I mix with the world which mixes with me” (Serres 2008, 80), the poem “The Circle” examines both our connection toward and disregard for the more-than-human world, and brings our focus down to the level of the oxygen atom.

The Circle

thoughtless breath
sucks in the world
lungs—an inverted tree
windpipe—a trunk to leafy alveoli
spider webs, air sacs
snare oxygen exhaled by gods
into a pulmonary cocoon

hemoglobin
filled with atmospheric spirit
vessels borne in plant and animal
the dance of O₂—chloroplast to mitochondria
leaves the twig for the capillary that
digs into muscle and bone

hormones pollinate
red blood cells—
billions of messenger bees
in an endless circuit
artery to vein, vein to artery
death comes slow to these gods of old
microscopic Hermes
runs the organ gauntlet
spleen to pancreas
to Stygian pituitary
a race toward a galaxy of synapses
home to thought
and mind
and memory
with the nerve to believe
you are different

oxygen is a circle
a ring that holds
gods and bees and blood
every thoughtless breath
exhales carbon for the trees
that still stand upright

Can we be mindful of our body, this taken-for-granted vessel that carries us through corporeal life? The backbone of life as we know it is carbon, and oxygen is the gas that allows our cells to respire. Is it possible—or necessary—to show gratitude for mere atoms? The complex efficiency with which our organ systems carry out such precise physiological processes is astounding, an “endless circuit” that runs for more
than a century, in some cases. With our “thoughtless breath” we contribute to the carbon cycle, expelling carbon dioxide into the atmosphere so plants or algae can photosynthesize sugars once more. Yet we are ignorant of our role in this cycle, as evidenced by the desperation with which we keep seeking and exploiting fossil fuels. Perhaps if we clearly acknowledged and understood, on a fundamental level, our reliance upon oxygen, our species would make greater haste toward a more sustainable path unreliant upon plants and animals long dead (e.g., fossil fuels such as petroleum and coal).

A Photographic-Ecopoetic Inquiry

Recently at the optometrist, my first visit in nearly twenty years, the doctor used an optomap to scan my eye. I excitedly asked to see the resultant photo and requested the jpeg, which showed an inverted image of my retina. Fascinated by the capillaries that looked like rivers flowing into my central optic nerve, this became a way to explore the wonder within myself. I wrote the following haiku:

inside my own eye
rivers of sight spiral down
inward crystal ball
I facilitated an activity with Education PhD students, showing them this image with no context. Their responses reveal the interrelations of thunderstorms, rivers, leaves, neurons and the human eye. These repeating patterns serve as a reminder of the unity in variety found across the biotic and abiotic worlds. Here are a few of their haikus:

Fragmented leaf veins  
light shining through the thin veil  
guides like a lighthouse  
~Tamara Pearl
Moon light and thunder
Power manifesting
In different forms
~Jade Ho

Subaltern vessels
Amazonian Rivers
Bursting by the sun
~Dave Chang

Our bodies are poetry. Patterns found inside reveal “fragmented leaf veins,” “moonlight” and “Amazonian Rivers.” In fifteen words or less, each student explored this image’s mystery to reveal varied and yet unifying perceptions of a natural/human phenomenon.

Microscopic life captivates me. Connor (2006) explains how the invention of the microscope transformed “the deprecation of what were thought to be imperfect and accidental creatures into confirmations of the extent and orderliness of divine design” (80) and that “early observers through the microscope reported their amazed delight at the intricacy and regularity to be found in creatures too tiny to be seen with the naked eye” (80–81). Thus microbes were granted a more noble status.

Dramatic and diverse life thrives in a single drop of pond water. Through the microscope, I once watched an amoeba ooze in eleven directions at once. I snapped two photographs. Then I pondered, How do these unicellular creatures differ from us? How are they the same? How do they perceive the universe? The following poem, “Intimate Immensity,” borrows its title from a chapter of Bachelard’s *The Poetics of Space*, where he also says “the daydream transports the dreamer outside the immediate world to a world that bears the mark of infinity” (1958/2014, 201). My poem searches for the infinite in the small, and elucidates the interrelatedness of all matter from planet to cell.
Intimate Immensity

bits of chromosome and membrane
    pregnant with nuclear gods
a cell in a microscope
    there lies infinity
    my hand
on my wife’s swollen belly
    I feel the kick of life
when two cells become one

a labyrinth of folded nebula
    layers of lipid and DNA
    inside my every cell
a coiled nest of centipede
    legs in constant motion
each part in touch with every other
    my son
    folded in the womb
his head on the placental pillow
    an umbilical cord I quiver to cut

welcome to this atomic ocean
that flows as an amoeba in love
morphs, swells, stretches into you
    a spring without shores
caged sunlight
I cradle my newborn
    in his first hour
his arms reach out
to hold the hand of galaxies
I watch
the Big Bang throw her chains of light
weave particles into comets of creation
the Little Bang throws her ribosomes
a midwife that delivers the code
    an egg turned planetary body
now my son runs through the grass
    his tiny body
    I love more than my own

I concede to my vast smallness
as we unravel the fluid mosaic
    the night sky an eclipse
my son moves his finger
from star
    to moon
    to his father’s eye
as though he is counting the universe
As a biologist who often works in a laboratory, magnified organisms are at once familiar and uncanny, the microscope a window into hidden worlds. The “vast smallness” in this “atomic ocean” opens our perception to new forms of life. Both this amoeba and I are made from stardust, our bodies organized by ribosomes. Whereas science offers a profundity of facts, the relational world is the source of the emotionally profound, the authentically human. Science certainly provides the bedrock for our knowledge of the universe, and a rational approach to objective discovery, yet personal stories and connections are what offer our lives meaning. Poetry can bridge static facts with dynamic feeling.
Bringing Poetry into the Science Classroom

“Science is the poetry of reality,” said Dawkins (2007). At first glance poetry and science seem like odd bedfellows; the former is lyrical, emotional, and multivocal, while the latter is pragmatic, rational, and does its best to stamp out subjectivity. Poetry and science are both informed by bias, and while an exceptional poem relishes some ambiguity, a proper science experiment nullifies uncertainty to the fullest extent possible. However, both crave exactitude: precision of language and methodology in the search for truth. Sound poetry and science recognize that our knowledge is incomplete. Poetry is not simply inventive words on a page the same way science is not simply a body of facts. Both are ways of knowing, and oblige creativity to be successful in the pursuit to find novel ways of studying something familiar.

Christopher Langton speaks to poetry and science thusly:

“There’s a reason for poetry...Poetry is a very nonlinear use of language, where the meaning is more than just the sum of the parts. And science requires that it be nothing more than the sum of the parts” (as cited in Horgan 1996, 201).

Science begins with wonder, as both a noun and verb: awe for the beautiful and inexplicable universe, and pondering on how it all operates. Bronowski (1956/1972) explains how “we are moved by the poem, we follow the theorem because in them we discover again and seize the likeness which their creator first seized” (27), suggesting that both science and poetry are paths to wonder. Hadzigeorgiou and Schulz (2014) define wonder as “astonishment and admiration,” separate from curiosity which is “a scientific impulse that strives to ‘dominate nature’” (1994); we want to cultivate the former through the lessons of Romanticism for a more collaborative engagement with nature. Bronowski (1956/1972) adds, “Science is nothing else than the search to discover unity in the wild variety of nature—or more exactly, in the variety of our ex-
Poetry strives to be succinct and incisive. A handful of well-chosen words can convey layers of meaning and question conventional thought. This becomes applicable in many contexts of pedagogy—the obvious being creative writing, expressive arts, and language studies—but I will focus on science education. Theory, concepts and terminology dominate the typical science lecture. If we look at Biology (Reece et al. 2014), a standard first-year biology textbook, it speaks to photosynthesis in this manner: “The electrons cycle back from ferredoxin (Fd) to the cytochrome complex and from there continue on to a P700 chlorophyll in the PS I reaction-center complex” (207). Rich in terminology and pinpoint accuracy, yet lacking emotion and personal relevance, this is the language that inculcates biology students. Part of the problem is that “educators are handed, and largely accept, the mandates of a standardized, ‘placeless’ curriculum and settle for the abstractions and simulations of classroom learning” (Gruenewald 2008, 317). If “science can only be perceived by life and remains dependent on the body of the scientist” (Noys 2013, 235) then we need to re-invigorate university science pedagogy with sensorial engagement. Ontological reversal displaces us from our senses and direct engagement by giving models and signs more importance than the actual phenomenon under study. Hadzigeorgiou and Schulz (2014) remind us that conceptual details and reductionist approaches can mask the wonder of scientific exploration, and bog learners down in free-floating abstractions.

However, this is not the only way to approach science education. The instruction of abstractions and simulations can be complemented (and in some cases, replaced) by reflection, creative exercises, and direct and dynamic engagement. Experiential learning that places student engagement and creativity at the center can be implemented in the science classroom, laboratory and field settings. “The concept of ‘the participant mode of consciousness’ can indeed help us with the selection of curriculum
activities” writes Hadzigeorgiou and Schulz (2014), “that have the potential to lead to holistic experiences. Certain immersion activities, like storytelling, poetry, and the arts, have such potential” (1991). The components of photosynthesis can be role-played so students embody the experience. The differences among animal phyla can be learned by mimicking their movements (Beavington 2016). Student-led presentations that are creative in nature give learners permission to wear costumes, facilitate interactive activities, and utilize arts-based approaches to engage with science. Such approaches can also be applied in chemistry and physics. Specific examples include having astronomy students embody planetary orbits or the moon’s movement in relation to the Earth. In chemistry, chemical reactions can be role-played with signs, or the astonishing properties of water can be presented by students through active and creative methods. And, of course, poetry is an evocative tool that can be used across the disciplines to bring the senses, creative learning, and reciprocity to the fore.

Neilsen (2004) contends that “poetry and inquiry ask us to listen deeply. We must put ourselves in the context; we must feel, taste, hear what someone is saying. Sometimes we must learn to listen under the words, to hear what is not being said” (41). In this way, poetry interweaves experience and creativity, and makes the inaccessible accessible by providing another source of insight into a myriad of topics, including photosynthesis. One activity I facilitate, preferably done outside, starts with students finding and sitting with a leaf. This exercise is similar to Carolyn Elliott’s (2012) definition of poetic inquiry as “a mode of thought and discovery that seeks to reveal and communicate truths via intuitive contemplation and creative expression” (iv). I invite students to engage with the leaf in silence using multiple senses. With the leaf in their hand, I ask them to ponder: “What aspects of the leaf surprise you?”, “If the leaf could speak, what would it say to you right now?” and “How is your hand like the leaf?” This contemplative approach encourages a sensorial and participatory engagement, and students reflect on their experience with the leaf by written reflection. Then they underline a word or short phrase, and one-by-one students place
these upon the floor, thus forming a collective poem. This method is less intimidat-
ing for those uncomfortable with writing poetry, and promotes collaboration. Pren-
dergast (2009b) questions, “What is the nature of the sediment upon which the
poem is written in response?” (xxxiv). The sediment here is slow pedagogy and in-
quisitiveness, which invites more personal and reflective responses.

After facilitating this activity with education PhD students, they constructed the
poem below. “Language is the place where alien otherness becomes adventure”
(Todres 2004, 40), and here the adventure takes the form of a brittle autumn leaf.

Life is not linear
Death is another beginning, another life

ridges of my fingerprints
kicking up tiny beats against the leaf
or is it the leaf’s veins drumming against my fingers?

red five fingered
veined soft and supple
handshake from the tree

the secret underside of the leaf

yet we walk by them
and on them without even thinking twice
Thank you little leaf.

A symmetrical shape none-the-less

linger with the memory
carry forth the joy
live the dying
Figure 3. A group poem inspired by the leaf.
In the discussion immediately following the leaf activity, the following terms (each mentioned multiple times by participants) were used to describe the experience: aliveness, concise, curious, emotion, heart, imagery, joy, moment, movement, pausing, prolonged looking, tactile, watching, wonder. What a wonderful bedrock from which to build their learning. Post-activity feedback from participants included feeling less daunted by using poetic language in learning, being more curious to hear the science behind the leaf, and opening up to the grief of loved ones recently lost. This is a lot closer to the realm of holism than “The electrons cycle back from ferredoxin to the cytochrome complex” (Reese et al. 2014, 207) and cultivates not only a sense of wonder for the leaf but also a relationality that is not possible when ontological reversal is employed; that is, when more abstract models and symbols of the phenomenon dominant, and the leaf itself lay forgotten.

Poetry can be introduced many other ways. Since “an artistic expression and a scientific experience can complement each other” (Hadzigeorgiou and Schulz 2014, 1977), I have used poems to introduce formidable terminology to students, and I have invited students to write poems about mitosis and embryonic development. Other approaches include students writing haikus about scientific phenomena, breaking students into groups to compose a poem on a particular concept, and using prose poetry to grapple with larger ethical issues that relate to scientific research (more on this in the next section). For now, I will address potential concerns and drawbacks of poetic learning in science.

Poetic language, with its imagery, ambiguity, and artistic license, has the potential to contradict established science. For instance, a poem about amoeba might suggest they have a mind of their own; this is a metaphorical mind, as amoeba completely lack neurons that make up our brain and nervous system. Some poets, such as Gerald Manley Hopkins, choose their words based on sound more than meaning, which can
lead to misconstrued ideas about science. Worse still, a poem could trivialize science, promote an anti-science mindset, or anthropomorphize other-than-human organisms. We do not want to forget the methods with which science excels: unbiased gathering of concrete data. This fountain of dispassionate knowledge can further our health, technology and well-being.

We absolutely need science and scientific language. Poetic inquiry is not a replacement, but a supplement. Poetry can provide learners with an initial relational connection to phenomena, so learners might be more willing to engage with difficult scientific concepts and terminology. Bronowski (1956/1972) reminds us that “We remake nature by the act of discovery, in the poem or in the theorem” (20). There is an opportunity to fuse “the knowledge, precision, and language of science with the voice, vision, and language of poetry to produce something unique” (Gorrell and Colfax 2012, 13). Poetry can be a bridge between wonder and daunting learning objectives, and a way to link what we learn to our personal lives, with care taken to avoid putting forth pseudoscience.

The Legacy of Romanticism

The Romantic era provided fertile grounds for natural philosophy, an integration of philosophy and science that reigned until positivism instigated their divorce in the 1840s. What important aspects of Romanticism can we reclaim? Romanticism, of course, embodied more than poetry. Other key characteristics include unity between humans and nature, careful observation via the senses, the importance of the aesthetic dimension, and the revolt against the idea of controlling nature, all of which, one could argue, are vital in today’s environmentally tumultuous climate.

When my students in the Amazon Field School gathered around the elder ceiba tree, and placed their hands on that ancient trunk, they were invited to embrace the legacy of Romanticism. That is, to find unity with nature, engage sensorially, and
step out beyond reason and etiquette to become permeable with their subjective selves. In this manner, perhaps they felt a kinship toward all their relations on our planet.

Whether students study an intact leaf in the classroom or travel to the remote Amazon rainforest, the objective is the same: to re-enchant science, engage in a participatory way with the life phenomena under study, and bridge the worlds of art, science and philosophy. Since “every human being lives in three spaces, which interpenetrate and complete but also partially contradict each other” (Uexküll 1934/2010, 54), poetry can serve as a link among these three spaces.

But the larger need, here, is to have science students address philosophical issues regarding the scientific paradigm, the underlying assumptions of the Cartesian-Newtonian outlook—not to mention all of the “shared silences and prejudices” (Bowers 2008, 327) of university education—and the ethical implications of various scientific research such as genetic engineering, stem cells, fetal bovine serum, and the pervasiveness of other-than-human animal experimentation. The reflective and provoking nature of poetry is one path toward philosophical discourse. Descartes (1649/1989) wrote that “wonder is the first of all the passions” (52) to which Irigaray (1993) adds, “The first passion is indispensable...to the creation of an ethics” (74). By starting with wonder, and complementing scientific investigation with poetry or other creative art forms, we as educators can rekindle both a passion for science and a passion for the philosophy of science.

It feels fitting to end this paper with poetry as found through the words of David Abram (2011), whose phenomenological approach to using the senses promotes deep engagement “between the body and the breathing earth” (3). Abram writes poetically, which serves to draw readers into our sensuous and symbiotic world. In his book *Becoming Animal* there is a chapter entitled “Shadow” that moved me to reconnect with my own shadow, and see my shadow as part of myself and the Earth. This final
poem was crafted from Abram’s words; each line is an intact phrase from Becoming Animal. The result is “a hand reaching straight into experience and arranging it with new meaning” (Bronowski 1956/1972, 18), and reaffirms the power of the poem.

Remembering Shadow
(words from David Abram)

born afresh every dawn
night’s gloom flees the advance of the rising sun
gift afforded by the sheltering shade of the mountain
torn from the black cloak every morning
defines the mood of this moment where you stand
letting it untangle your senses

the country of shadow
breathing body of the mountain itself
voluminous being of thickness and depth
touching me
at every point of my person

absorbed through the pores of my skin
seeping in to my flesh
my personal night
enfolded within me

tutored by the darkness
disruption of the sun’s dominion
inescapable consequence of our physicality
this shadow that eats all other shadows
indistinguishable from me
carries us out of ourselves into Earth’s own awareness
References


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Lee Beavington is a SSHRC scholar and PhD candidate in Philosophy of Education at SFU. He is also an award-winning author and photographer, and has taught a wide range of courses and labs at Kwantlen Polytechnic University including Ecology, Genetics, Expressive Arts, Marine Biology, and the Amazon Field School. His interdisciplinary research explores wonder in science education, poetic inquiry, and arts-based learning across the curriculum. Find Lee reflecting in the forest, mesmerized by ferns, and always following the river. More about Lee at www.leebeavington.com.

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